The Pakistan Development Review
40 : 2 (Summer 2001) pp. 115–133

Performance of the Public Electric Power Industry: Evidence from Pakistan

ABDUL GHAFOOR and JOHN WEISS

The study investigates the performance of electric power sector of Pakistan at the firm level, as well as the sector as a whole. It identifies and attempts to quantify the extent of inefficiencies. Since either physical or financial or productivity indicators alone are not able to explain the duality of public infrastructure purposes and the complexity of their multi-dimensional goals, a set of relevant physical, financial, and productivity indicators have been used in evaluating the performance of this sector. Further, a Cobb-Douglas production function has also been used to calculate the trend in the growth of total factor productivity. Economies of scale have also been studied in the case of electric power generation.

1. INTRODUCTION

In recent years, considerable emphasis has been placed on the potential for private capital to play an important role in infrastructure development, either through direct purchase of state enterprises and mixed ownership arrangements or a form of Build-Own-Operate-and-Transfer (BOOT) scheme. In part, this stems from the difficulties faced by many governments in raising additional funds for large infrastructure investments. In addition, however, a second factor has been the widely-held perception, expressed clearly by World Bank (1995), that state enterprises in most countries have operated with considerable inefficiency, particularly in infrastructure, where the large capital involved and the potential for external effects at one time appeared to make infrastructure investments natural candidates for public provision. There is a body of theory, based on a lack of property rights and lack of market discipline, which attempts to rationalise the case for inherent public sector inefficiency [Adam, *et al*. (1992)]. However, this does not convince everyone, and to make a firm case for privatisation there is a strong need for further empirical studies that demonstrate how public sector infrastructure enterprises have actually performed.

Abdul Ghafoor is Associate Professor/Director, Institute of Social Sciences, and Acting Dean, Faculty of Communications, Cyprus International University, Lefkosa, Mersin 10, Turkey. John Weiss is Professor of Development Economics at the Bradford Centre for International Development, University of Bradford, U.K.

This paper attempts to contribute to this area by evaluating the performance of the public sector enterprises of electricity industry in Pakistan during the period 1960–95. The following section of the paper sets out briefly the development of this sector in Pakistan. The third gives financial indicators for the enterprises involved. As is frequently the case, judgments based on financial data on enterprise performance can be misleading and, therefore, the fourth section considers evidence based on estimated total factor productivity growth, which gives a quite different picture on performance. Finally, the fifth section draws some conclusions.

2. THE DEVELOPMENT OF ELECTRICITY IN PAKISTAN: AN OVERVIEW

Pakistan's two power utilities are the Water and Power Development Authority (WAPDA) and the Karachi Electricity Supply Corporation (KESC). The former has a national coverage, whilst the latter serves only the Karachi division and related areas. WAPDA's power plants are a mix of hydel and thermal supplies, whilst KESC's are all thermal. Growth in power generation has been very substantial, with an increase in aggregate supplies of approximately 12 percent annually from 1960 to 1995. Over the same period, per capita power availability increased from 28kwh to 444kwh.[1] System losses in the sector, at 24 percent in 1990, were relatively higher than in many other industrial and developing countries [World Bank (1994)]. Both WAPDA and KESC are vertically integrated in the production, transmission, and distribution of power, and although they are not subject to rate of return regulation, price increases must be approved by the government. In real terms, the average unit price for power has remained largely constant, with some annual fluctuations, between 1960 and 1995 at around rupees 1.0 per kwh of WAPDA and around rupees 1.20 for KESC.[2] However, comparative tariff data suggests that in dollar terms, tariffs in Pakistan, at least in the 1980s, were well below those in comparable economies in the Asian region [Malhotra, *et al*. (1994)].

Loadshedding[3] by the two companies has been seen as a major problem over the period under consideration and several studies have suggested that power bottlenecks have imposed serious costs on the Pakistan's economy. For example, Pasha and Gellerson (1988) and Ali (1990) calculated the loss in industrial output from factory closures due to power cuts. The former suggested it might be 9 percent of annual industrial output (i.e., a loss of 0.9 billion US dollars or about 2.25 percent of GDP). The latter put the annual cost in lost GDP at 1 billion US dollars (i.e., about

[1]Data cited here come primarily from the published reports of the companies. For full information on the sources, see [Ghafoor (2000), p. 223.]

[2]The real prices are calculated on the basis of year 1990.

[3]Loadshedding means rationing of electricity at the time of shortage.

2.5 percent GDP). In a production function approach, USAID (1988) estimated costs of loadshedding at nearly 2 percent of GDP and a fall in manufactured exports of 4 percent.[4]

Despite a substantial increase of electric power generation during the past decades, the performance of this sector has been criticised on the basis of inadequate facilities relative to the growing demand. Since the efficiency of this sector is doubted today, it faces alternative policy reform such as build-own-operate-and-transfer (BOOT), build-transfer-operate (BOT), lease-develop-operate (LDO), and vertical disintegration[5] [Ziauddin (1997) and *Dawn* (1997)]. Therefore, the intent of the present study is to investigate the performance of electric power sector of Pakistan at the firm level, as well as the sector as a whole, and identify and quantify the extent of inefficiency in the case of poor performance.

3. METHODOLOGY

Public enterprises in general and public infrastructure in particular are expected to fulfil complex multi-dimensional goals,[6] which makes it difficult to devise a satisfactory procedure to assess their performance. Although many studies on public enterprises are limited to the profitability criterion,[7] it is unfair to evaluate this multi-objective sector on financial bases only. However, the financial criterion cannot be neglected because of the overall budget constraint of the government. Thus, literature suggests that financial indicators must be used in conjunction with the factor productivity criteria. However, these criteria could be applied to commercial objectives only.

As regards non-commercial objectives, Millward and Parker (1983); Jenkins and Lahouel (1983) and World Bank (1995) suggest that performance should be evaluated on the basis of cost effectiveness or unit cost of production while Pryke (1981) and OECD (1990) argue that the physical yardstick is neutral regarding ownership and social and economic costs and benefits.

By considering all these arguments, it could be concluded that the performance of public enterprises should be evaluated through a basket of indicators, that should contain physical, financial, and productivity indicators relevant to the enterprises under consideration. A list of selective indicators used in the present study is shown in Table 1.

[4]The variation among these results might be due to various units and different methodologies. It is, however, clear that in the past loadshedding had caused a serious damage to the economy.

[5]Literature also uses the word "unbundling".

[6]Such as income distribution, industrial development, employment, etc.

[7]For a detailed discussion on the subject, see Mann (1970); Peltzman (1971); Meyer (1975); Parsons (1980); Galal, *et al.* (1994); World Bank (1995) and Sarma (1995).

Table 1

Selective Indicators to Evaluate the Performance of Public Electric Power Industry in Pakistan

Group	Indicators
Physical	Growth in Physical Output
	System Losses
	Generation Capacity Factor
Financial	Net Profit Margin on Sale
	Return on Capital
	Unit Cost of Production
Productivity	Labour Productivity
	Capital Productivity
	Growth in Total Factor Productivity

Source: Data and other information were obtained from published material of relevant enterprises and from The Planning Commission of Pakistan. These included Annual Reports, Power System Statistics, Five-Year Development Plans, etc. For full information on sources, see [Ghafoor (2000), p. 223.]

4. PHYSICAL PERFORMANCE

Table 2 indicates that the growth in total electric power generation decreased both in WAPDA and KESC during 1960–77. In the case of WAPDA, it may be a combined effect of its early period of establishment, a very slow progress on generation projects due to lack of resources, and rapidly changing government policies on power development. The same may be true for KESC except that it was already established and was expected to perform better than WAPDA. Later, growth in total generation increased, which may be due to commissioning of the Terbela units and installation of new vintage steam and combine cycle power plants at various places in the case of WAPDA, and the establishing of a nuclear power plant outside Karachi in the case of KESC. However, there may be various reasons for the later downward trend in growth of power generation such as malfunctioning of nuclear power plant, inadequate maintenance of old plants, negligible replacement of old age plants, etc.

Although the growth in power generation was substantial during the period under consideration (an average increase of 12 percent per annum), the demand grew even faster and power shortage became a serious problem, which forced the rationing of power supply. A simple reason for this outcome may be inefficient use of available installed capacity. Table 2 shows the generation

Table 2

Selected Physical Indicators for Evaluating the Performance of State-owned Electric Power Industry in Pakistan (1961–95)

Years	Growth in Power Generation (%)			System Losses (%)			Generation Capacity Factor (%)		
	WAPDA	KESC	Power	WAPDA	KESC	Power	WAPDA	KESC	Power
1960–65	26	17	24	26	17	24	34	47	36
1966–71	15	14	15	31	19	28	45	42	44
1972–77	7	4	7	34	22	32	46	42	45
1978–83	12	9	12	32	23	31	50	48	48
1984–89	10	12	10	26	26	26	52	50	50
1990–95	8	5	8	23	33	26	54	50	52
Average	**13**	**10**	**12**	**29**	**33**	**28**	**47**	**47**	**46**

capacity factor,[8] to analyse the capacity utilisation in WAPDA, KESC, and power industry as a whole. Although the generation capacity factor was well below that of WAPDA (34 percent) relative to KESC (49 percent) during 1960–65, it gradually increased over time and went up to 54 percent during 1990–95. On the other hand, in the case of KESC, it decreased during 1960–77, and then increased again during 1978–95 and went up to 50 percent. However, the average generation capacity factor for the power sector as a whole (46) is as good as that for other developing countries such as Hong Kong (43), Malaysia (42), and the Philippines (46.9) [Ghafoor (2000), p. 170]. Therefore, shortage of electricity cannot be blamed on inefficient use of available installed capacity. However, in the case of electricity, the total production could be different from actual delivery to the consumers, and this difference is called system losses. These losses may be due to technical reasons such as unreliable and aging generation plants, low-voltage transmission, and distribution lines and inappropriate location of grid stations, as well as non-technical factors such as inaccurate metering and billing, default payments, un-metered supplies, and theft (through illegal connections).

Table 2[*] and Figure 1 show the total system losses[9] of WAPDA, KESC, and the total power industry during 1960–95. In the case of WAPDA, total system

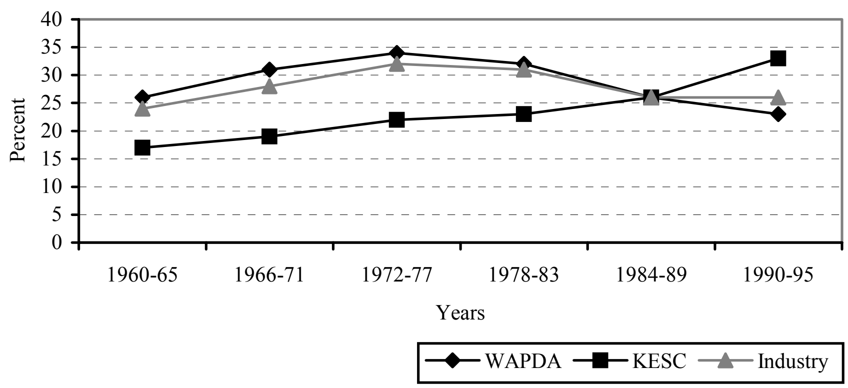

Fig. 1. Total System Losses of WAPDA, KESC, and Power Industry as a Whole during 1960–95.

[8]Generation capacity factor is expressed as follows [Humplick (1993)].

Generation Capacity Factor = {Annual Gross Output (MWh) / Annual Installed Capacity (MW) x 8760} x 100.

Where, 8760 are total number of hours in a year of 365 days.

[9]Total system losses include auxiliary (the amount of electricity used with the generation process), transmission and distribution losses.

[*]Tables follow the main text and References.

losses[10] increased from 26 to 38 percent during 1960–77. However, these losses decreased to 23 percent during 1978–95. On the other hand, during 1960–77, total system losses of KESC were very low (from 17 to 22 percent) relative to WAPDA, but they gradually increased over time and went up to 33 percent during 1990–95. Since WAPDA has the largest share in total power industry, power industry has followed a trend similar to WAPDA's. The average system losses (28 percent) are, however, substantially higher than in other developing countries such as India (19 percent), China (15 percent), the Philippines (19 percent), and Hong Kong (11 percent) [Ghafoor (2000), p. 169)].

5. FINANCIAL PERFORMANCE

Public enterprises are often heavily criticised for making financial losses, which must be financed from central government budgets, contributing to budget deficits and macro-economic instability. Such criticisms can be misplaced in situations in which the prices that such enterprises are allowed to charge are not allowed to rise in line with costs. Apparently, this has not been a problem for these enterprises in Pakistan, since neither sector has operated with financial losses for any significant time when net profit margin on sales was calculated before and after actual interest paid[11] (Table 3). However, net profit margin on sales was substantially decreased when actual interest payments were included into total costs. It indicates that a large part of investment is through borrowing and, therefore, net profit is very sensitive to interest payments. Analysis of returns on capital[12] is also telling a similar story (Table 4).

Financial data can be highly misleading, however, whenever markets are distorted by controls or function poorly due to lack of information or structural rigidities. The key to interpreting the results in Tables 3 and 4 lies in the terms on which finance was made available to the enterprises over this period. For example, WAPDA and KESC received grants from federal and provincial governments for specific jobs. For instance, the Ministry of Water and Power provided funds from its current expenditure budget for ongoing research schemes, such as the Khanpur and Hub

[10]Total production could be different from actual delivery to the consumers and the difference between two two is called system losses. These are expressed in percentage terms and defined as the difference between total production and actual delivery as a proportion of total production [Humplick (1993)].

[11]The most familiar concept of financial profit measures, the ratio of net profit (difference between total revenue and total cost) on sale, has been used in this study. Total revenue includes the revenue on sale of electricity and other operating revenue such as meter rent, late payment, other surcharges, etc., and total cost includes cost of generation (fuel cost, depreciation), transmission cost, distribution costs (selling, administration, research and development) and interest payments. Furthermore, net profit margin on sale has been calculated both before and after interest to demonstrate the significance of interest payments.

[12]A detailed discussion on how the capital was calculated in this study has been made in the next section, under productivity analysis.

Table 3

Various Concepts of Net Profit Margin on Sale of State-owned Electric Power Industry in Pakistan (1960–95)

Years	Net Profit Margin on Sale before Interest (%)			Net Profit Margin on Sale after Interest (Actual) (%)			Net Profit Margin on Sale after 10 Percent Opportunity Cost on Capital (%)		
	WAPDA	KESC	Power	WAPDA	KESC	Power	WAPDA	KESC	Power
1960–65	31.49	29.94	34.33	5.68	20.37	13.96	–65.26	–29.28	–51.85
1966–71	34.98	26.40	35.17	4.51	19.24	10.71	–63.61	–26.25	–52.75
1972–77	26.15	8.20	25.28	–1.32	–0.38	1.50	–98.94	–88.58	–90.66
1978–83	48.72	18.09	42.85	29.86	9.31	25.93	–42.34	–45.65	–44.21
1984–89	33.46	17.01	31.77	15.54	5.27	14.82	–37.38	–50.65	–35.90
1990–95	39.40	13.74	36.29	19.93	0.07	17.53	–26.43	–34.95	–28.88

Table 4

Various Concepts of Return on Capital of State-owned Electric Power Industry in Pakistan (1960–95)

Years	Return on Capital before Interest (%)			Return on Capital after Interest (Actual) (%)			Return on Capital after 10 Percent Opportunity Cost on Capital (%)		
	WAPDA	KESC	Power	WAPDA	KESC	Power	WAPDA	KESC	Power
1960–65	3.34	4.89	4.06	0.65	1.84	1.69	–6.66	–2.93	–5.94
1966–71	3.57	4.51	4.02	0.47	0.96	1.23	–6.43	–6.21	–5.98
1972–77	2.16	1.49	2.28	–0.05	–0.23	0.21	–7.84	–8.11	–7.72
1978–83	5.52	3.76	5.06	3.45	1.51	3.11	–4.48	–1.28	–4.94
1984–89	4.80	3.29	4.73	2.26	0.19	2.33	–5.20	–5.91	–5.27
1990–95	6.02	2.83	5.60	3.05	0.05	2.71	–3.98	–5.17	–4.40

Dam projects. Funds for electrification projects were provided by the respective provincial government as a grant. WAPDA also received a continuous special grant from the Public Sector Development Programme (a federal government scheme to finance the public sector).

Most of the local loans were either at low interest rates or were interest-free. For instance, KESC received an interest-free loan of Rupees 132.57 million from the federal government in 1982 for electrification of Balochistan province. Where interest was paid, it was very low as compared to the interest paid by private borrowers.

Moreover, there was a hidden subsidy on foreign loans. For instance, both WAPDA and KESC repaid their loans to the Government of Pakistan in local currency at the rate of exchange prevailing on the respective dates of disbursement. Any inflation and the resulting increase in debt service were paid by the government, not the enterprises. Further, KESC also received a subsidy from the Government of Pakistan ranging from 3.25 percent to 6.75 percent per annum on outstanding foreign loans. This indicates that the total financial cost of electricity supply was well below the real economic cost incurred.[13]

It is not possible to quantify the precise impact of each individual component of financial assistance, due to unavailability of actual amount of grants, local and foreign loans over 36 years, and the complications involved in their valuation. However, an approximate indication can be obtained by using a fairly acceptable opportunity cost of capital employed. Therefore, the actual interest rate was replaced by a notional real annual capital charge set at 10 percent of capital assets in a particular year.[14] In Tables 3 and 4, revised profitability ratios are given with profit net of this notional capital charge rather than actual interest paid. Now it can be seen that the two power enterprises are significantly unprofitable in all years. The implication is that in financial terms, none of the enterprises was able to generate a surplus equal to the estimated opportunity cost of investment funds, and that users were not charged tariffs that reflected the true costs of supplying electric power.

Apart from a monopoly behaviour, a higher ratio of net profit margin and net return on capital implies a better performance of a firm. It does not mean that the firm with a lower rate of profit is inefficient. For instance, a firm might be minimising cost for a given output even though profits are not maximised due to price control by the government. On the other hand, high profits do not necessarily reflect efficient firms since the objective of profit maximisation can be achieved by exercising monopoly power to obtain factor inputs at unduly low prices or through selling products at higher than competitive prices. Therefore, profitability and ratios associated with it are ambiguous performance indicators and can be misleading if a

[13]It, however, can be said with assurance that in either case, whether it is grant for a specific project or subsidies on foreign or local loan, the sum entered the capital stock figure.

[14]In an earlier study, Weiss (1980) also estimated a similar opportunity cost of capital of 10 percent for Pakistan in the late 1970s.

firm operates in a monopolistic environment or the government controls the price of output. Since both WAPDA and KESC are monopolistic firms and the government controls prices, high profitability before and after actual interest paid could be criticised on the ground of high rates of tariff. In this situation, the efficiency of firms could be examined in two ways: first, by looking at the trend in real price of electricity throughout the period under consideration; and, second, by examining the unit cost of production.

Figure 2 shows that the price of electricity in the case of WAPDA has fallen slightly in real terms in the long run. Since WAPDA and power industry as a whole show an upward trend in net profit margin, the high profit is unlikely to be a function of higher price. On the other hand, the real price of KESC has increased over time because of higher fuel adjustment charges in 1985-86. It indicates that the declining trend in net profit margin on sale in KESC may not be due to low prices.

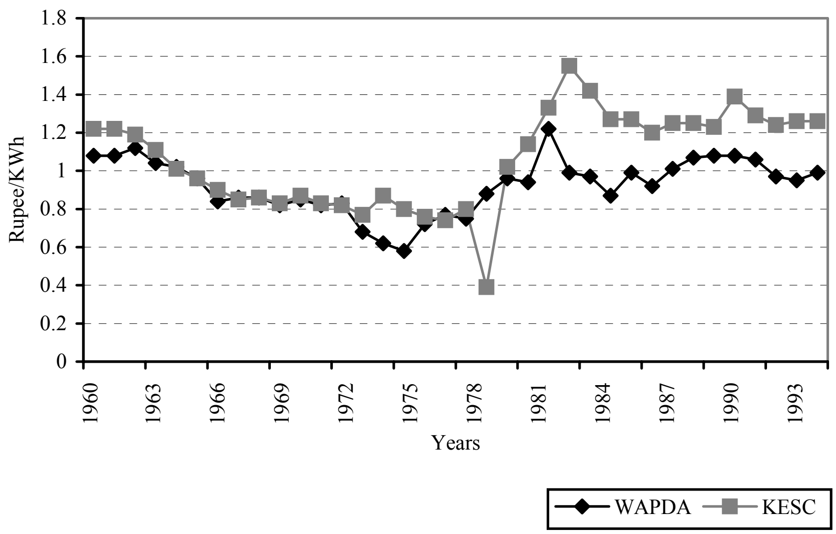

Fig. 2. Unit Price in Real Term for Electricity in the Case of WAPDA and KESC during 1960–95.

Regarding unit cost of production, Table 5 indicates that there is a general downward trend in all four concepts of unit cost during the period under consideration.[15] It is, however, important to note that the declining trend in unit cost was faster in the case of WAPDA relative to KESC. It is because the power system

[15]Since public managers do not have any control over interest and fuel price, evaluation of their performance would be misleading by including these costs. Therefore, a concept of controllable cost has been included in this study which measures the performance of sate-owned enterprises by looking at cost without interest and fuel cost.

Table 5

Various Concepts of Unit Cost of Production (Rupees) of State-owned Electric Power Industry in Pakistan (1960–95)

Years	Unit Cost before Fuel Cost and Interest			Unit Cost before Interest			Unit Cost after Actual Interest Paid			Unit Cost after 10 Percent Opportunity Cost of Capital		
	WAPDA	KESC	Power	WAPDA	KESC	Power	WAPDA	KESC	Power	WAPDA	KESC	Power
1960–65	0.42	0.52	0.45	0.53	2.15	0.56	0.73	2.21	0.77	1.29	2.67	1.31
1966–71	0.26	0.38	0.27	0.38	1.63	0.40	0.56	1.68	0.57	0.95	1.99	0.96
1972–77	0.24	0.45	0.26	0.33	1.46	0.36	0.46	1.53	0.48	0.90	1.95	0.92
1978–83	0.24	0.36	0.26	0.33	0.78	0.39	0.45	0.85	0.50	0.91	1.25	0.96
1984–89	0.27	0.42	0.29	0.48	0.75	0.52	0.61	0.87	0.65	0.99	1.24	1.04
1990–95	0.24	0.37	0.25	0.47	0.59	0.51	0.63	0.72	0.66	1.00	1.07	1.03
Average	**0.28**	**0.42**	**0.29**	**0.42**	**1.23**	**0.45**	**0.57**	**1.31**	**0.60**	**1.01**	**1.70**	**1.04**

of WAPDA consists of hydel and thermal power plants, while KESC consists of only thermal power plants. Since, hydel power is cheaper than thermal, any increase in hydel power will reduce the average unit cost of generation. Historical data indicate that WAPDA started with a high proportion of hydel power, which substantially increased during 1968–83 due to the commissioning of Tarbela and Mangla units. Therefore, WAPDA shows a lower cost as compared to KESC over the period under consideration.

6. ECONOMIC PERFORMANCE

As financial information gives only a very partial and misleading picture of performance, it is necessary to go further and consider the economic efficiency of the enterprises. For this purpose, we use a production function approach to estimate the trend in growth of total factor productivity (TFP) over the period studied. TFP should capture the improvements in the efficiency of factor use since it reflects growth in output that is not attributable to growth in factor inputs. We use the following version of the Cobb-Douglas production function where t represents time, V_t measures real value added, K_t measures capital[16] input and L_t measures labour input.[17]

$$V_t = A_0 e^{\lambda t} K_t^{\alpha} L_t^{\beta} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where A_0 = Scale parameter.
λ = Growth rate of productivity.
α = Elasticity of output with respect to capital, holding labour constant.
β = Elasticity of output with respect to labour, holding capital constant.
t = Time.

[16]The series for capital are generated with the help of the formula, i.e., $K_t = K_{t-1} + (\Delta K_t)$, where K_{t-1} is initial level of capital (which was total assets after depreciation) and ΔK_t represent the change in capital in current year {(Net Fixed Assets +Work in Progress) – Depreciation} + Working Capital {(Current Assets – Current Liabilities)}. All figures have been calculated on the basis of constant price of 1990 by using consumer price index.

[17]Labour is the total number of employees in a firm as given by the Annual Reports of these firms. Some economists believe that the number of employees at a given time-period is not a good variable since it does not take into account the quality of individual worker. Therefore, a better measure such as the weighted cost of labour according to their wages should be used. It can be argued that the main objective of such study is not to estimate the productivity of individual worker but an average productivity of the whole labour force working in a firm. Furthermore, the wage system in Pakistan is very complex and it is hardly mentioned in the published material on individual basis. Moreover, pay scales are revised by the Government of Pakistan from time to time and it is very hard to find such detailed information for 35 years. It is also believed that the salary does not reflect the true picture of labour quality. Therefore, we decided to use the number of workers, which seems to be a better measure in this situation. However, since the quality of labour did improve during the study period, our productivity growth would be slightly upward-biased.

Since the function is non-linear, we estimate Equation (1) as,

$$v_t = a_o + \lambda t + \alpha k_t + \beta l_t + e_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (2)$$

where the lower case indicates that logarithms are used. The intercept a_o reflects the initial level of productivity, and λ reflects growth of TFP as discussed above.

In our analysis we use real value-added, to avoid the distortion caused by the price control policy of the government. Nominal value-added is deflated by the price index for electricity output using a base year of 1990. A complication arises when a function such as this is estimated for sectors, like power, where there are discontinuous jumps in capacity, since this will disturb the underlying relationship between factors and output. To cope with this problem, we use a dummy variable for each jump in capacity.[18]

Hence our final version of Equation (1) for power will be,

$$v_t = a_o + \lambda t + \alpha k_t + \beta l_t + \gamma_1 D_{c1} + \gamma_2 D_{c2} + e_t \quad \ldots \quad \ldots \quad \ldots \qquad (3)$$

where D_{c1} and D_{c2} refer to dummies for each jump in capacity for the years 1968 and 1983, respectively. Table 6 reports our results for the power sector.

The estimated equation has performed fairly well and all parameter estimates are statistically significant. The DW statistics are also acceptable.

Referring to Table 6, the intercept 'a_0' provides information about the initial level of total factor productivity, which is negative in the case of WAPDA, while the coefficient λ**,** giving the growth rate of total factor productivity, is positive for WAPDA. These results indicate that although WAPDA had negative productivity[19] at the start of the period, total factor productivity has grown at a rate of 1.52 percent.

On the other hand since KESC was established in 1913 and working at full capacity in 1960, a higher level of technical efficiency, and consequently higher level of initial productivity, was expected. A positive sign of the intercept confirms that

[18]In the case of WAPDA, the first jump was caused by the commissioning of 6 units of Mangla Dam during 1968. It added 600 MW to the total generating capacity which increased growth in power generation from 4 percent to 19 percent. A second jump was due to the commissioning of 4 units of Terbela Dam and two more units of Mangla Dam, which added 960 MW to the total installed capacity and increased the growth in power generation to 33 percent in 1983. In the case of KESC, there was only one large jump during 1985 due to the commissioning of Bin Qasim thermal power plant of 420 MW capacity, which increased the growth in electric power from 17 percent to 24 percent. Since these additions caused a large increased in installed capacity, it would certainly lower the measured productivity in the short run. These dummies have been used to neutralise this disturbing effect which is assumed to last for just one year.

[19]In constant growth models, as used in this study, the intercept estimates the real value of the value-added in the initial year. It means that in our case the value-added was negative in 1960, with inputs and outputs valued at 1990 prices. There could be several reasons for this outcome. The main reason may be that WAPDA was in its development stage, where the cost of production was always higher than the revenue because most of generation plants were not working at full capacity. Therefore, output was relatively well below input costs.

Table 6

Parameter Estimates of Electric Power Industries in Pakistan Using Cobb-Douglas Production Function

Parameters	WAPDA	KESC	Power Sector
a_o	–2.0418	3.1228	–2.1124
	(–3.49)**	(3.67)**	(–2.39)*
λ	0.0152	–0.0165	0.0037
	(3.21)**	(–3.33)**	(3.18)**
α	0.6829	0.8119	0.6948
	(3.97)**	(3.92)**	(3.58)**
β	0.5421	0.2107	0.5224
	(4.10)**	(3.21)**	(3.61)*
γ_1	0.1443	0.3061	0.1481
	(4.04)**	(3.01)**	(2.27)*
γ_2	0.1719	–	0.1248
	(2.47)*		(3.19)**
Adj. R^2	0.57	0.59	0.62
DW	1.87	1.82	1.69

Figures in the parenthesis are *t* values.
* The coefficients are significant at 5 percent level.
** The coefficients are significant at 1 percent level.

KESC had a relatively higher level of initial productivity than WAPDA. However, total factor productivity has declined at a rate of –1.65 percent which indicates that the technical efficiency of KESC has deteriorated over time. It could be concluded that although WAPDA was relatively less efficient than KESC in the early period of its establishment, it has performed better in the long run, with a modest but positive growth rate of TFP. On the other hand, KESC shows slightly higher productivity in the earlier period, but the situation has deteriorated over time because of a significant decline of TFP. Total factor productivity for the electric power sector as a whole has grown, however modestly, at a rate of 0.37 percent.

Although only two firms are involved in the power sector, inter-firm differences in the growth of TFP are confirmed through a panel data approach, by including another dummy variable representing inter-firm difference (D_f) in the Equation (3) in addition to capacity dummies. Results of the panel data approach are shown in Table 7.

Table 7

Parameter Estimates, Using Cobb-Douglas Production Function with Panel Data

Parameters	Coefficients
a_o	–3.2457
	(–3.39)**
λ	0.0039
	(3.41)**
α	0.7981
	(4.30)**
β	0.5526
	(3.94)**
γ_1	0.1928
	(3.99)**
γ_2	0.1134
	(3.91)**
γ_3	0.0349
	(3.01)**
D_f	–0.0941
	(–3.89)**
R^2	0.65
DW	1.80

Figures in the parenthesis are *t* values.
* The coefficients are significant at 5 percent level.
** The coefficients are significant at 1 percent level.

The coefficient for firm dummy is negative and statistically significant at 1 percent level. Since WAPDA is represented by zero and KESC by one, the negative sign confirms that WAPDA is technically more efficient than KESC and these inter-firm differences are statistically significant.

Our results also indicate increasing returns to scale. For the power sector, the sum of the partial elasticities is greater than unity (0.70+0.52=1.20). So far as the individual electricity companies are concerned, WAPDA has a greater sum of partial elasticities than KESC but both have sums greater than unity, indicating increasing returns. The lower figure for KESC is due to a technology mix (thermal plants only as compared to hydel and thermal for WAPDA) as well as the productivity differences noted above.

Our economic indicator, TFP growth, gives a very different picture of performance to the financial indicators. The results imply that only a very low proportion of growth is due to improvements in the efficiency of factor use. However, there is no absolute benchmark with which these TFP results can be compared. Some sector studies have revealed significant TFP growth in publicly owned infrastructure enterprises. For example, Pryke (1981) estimated TFP growth of 8 percent annually for the UK electricity sector in the period 1968–73, which is well above the WAPDA growth of 1.4 percent. However, later work on the UK for the period 1978–83 found a much lower TFP growth, of broadly the same rate as that of WAPDA [Molyneux and Thompson (1987)].[20] It may not be fair to compare the performance of Pakistan's public enterprises with those in developed economies, but it is reasonable to expect modest, and positive, TFP growth from important state-run enterprises.

7. CONCLUSIONS

Our results show that although WAPDA has performed slightly better than KESC, neither of the enterprises has done well in the long run. For instance, in terms of financial performance, the average annual net profit after interest, as a proportion of sale for both WAPDA (12 percent) and KESC (9 percent), is substantially lower than net profit for the public corporation for electricity in Turkey, i.e., in the range of 20-36 percent.[21] In terms of economic performance, TFP growth has been negative in the case of KESC and relatively low in the case of WAPDA, as compared to the TFP growth calculated by Pryke (1981) for the electric power industry in the United Kingdom, i.e., 8.7 percent. This does not confirm the case for privatisation *per se*, but it does indicate the need for improvement on past performance. Therefore, the case for reforming these enterprises is strong, and alternative modes of organisation, finance, and ownership need to be considered.

In Pakistan, as elsewhere, there has been some discussion of ways of involving private capital in infrastructure development activities.[22] In the context of the power sector, most attention is given to ways of unbundling integrated public enterprises; thus for example in power, separating generation, transmission, and distribution, and introducing competition between suppliers. Therefore, the issue should not be the ownership, but rather an appropriate reform package that could suit the specific environment for economic development of Pakistan.

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[20]The variations among these studies may be due to various time-periods and methodologies used. It is, however, important to note that the performance of public enterprises has deteriorated in the long run.

[21]Karata (1995).

[22]Tenenbaum, *et al*. (1992) and Bhattacharyya (1995) discuss alternative models for power sector reform.

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